



Extensive cervical spine and foregut anomaly in ‘serpentine syndrome’

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ABSTRACT

INTRODUCTION: We report an extremely rare and challenging combination of congenital anomalies. Only five similar cases have been described in the English language medical literature to date.

PRESENTATION OF CASE: A male infant was born at 30⁺5 weeks gestation by emergency caesarian section. Cervical spine rachischisis, shortened oesophagus, intrathoracic stomach, atretic duodenum and absent spleen were noted, in addition to respiratory insufficiency. Gastrointestinal re-anastomosis, particularly oesophageal lengthening, was not feasible at the initial thoracotomy. Surgical stabilization of the cervical spine was unlikely to be successful until two years of age. Asplenia predisposed the infant to sepsis from encapsulated organisms, and recurrent respiratory infections occurred.

DISCUSSION: A close relationship exists between the upper gastrointestinal tract and cervical spine during embryonic development. An embryonic aberration at this level could account for all the deformities present in this infant. Tethering of the embryonic cervical oesophagus to the somites in the first trimester, preventing foregut elongation, and producing ischaemia at the coeliac axis, is suggested as the aetiology. **CONCLUSION:** This case presented a challenge to the multi-disciplinary team involved in his management and prompted extensive consultation with international experts. After considerable counseling of the parents, care was directed towards palliation.

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1. Case report

The authors obtained consent for this case report from the parents of the infant described.

A 37 year old healthy primigravida was admitted to a district hospital with antepartum haemorrhage. Both parents (non-consanguineous) had been counselled antenatally following detection on ultrasound of a probable congenital diaphragmatic hernia. Amniocentesis at 22 weeks was normal and the pregnancy was otherwise uncomplicated. Chromosome analysis confirmed a normal male karyotype. No microdeletions or chromosomal duplications were found on further testing.

A male infant was born by emergency caesarean section at 30⁺5 weeks gestation. He was not dysmorphic and had a birthweight of 1.7 kg (50th–75th centile). Respiratory insufficiency at birth necessitated intubation, surfactant administration and mechanical ventilation prior to transfer to the regional neonatal intensive care unit. A chest radiograph demonstrated curling of an oro-gastric tube within the thorax, and cervical vertebral anomalies (Fig. 1). Upper gastrointestinal contrast studies confirmed a total intrathoracic stomach, and no contrast passed distal to the stomach (Fig. 2). Laparotomy and right thoracotomy on day 3 of life

confirmed the presence of a shortened oesophagus, atretic proximal duodenum and absent spleen. Biliary structures were not observed. Both hemi-diaphragms were intact. The stomach was tethered by the shortened oesophagus and could not be mobilized into the abdomen at the time of the original surgery, therefore a proximal small bowel stoma was formed to facilitate enteral feeding. The blood supply to the stomach and duodenum was from a caudad direction arising from below the diaphragm and therefore assumed to be from the coeliac axis.

Patency of the distal small bowel and colon was demonstrated by contrast studies. Asplenia required phenoxymethylpenicillin prophylaxis from encapsulated organisms, which was delivered via the stoma. Absence of splenic tissue was confirmed later by the presence of Howell-Jolly bodies on blood film.

Enteral feeding proved difficult to establish, and the infant developed cholestasis with parenteral nutrition. Introduction of a hydrolysed formula with addition of aspirated bilious gastric contents to the feed enabled tolerance of full enteral feeding by day 36 of life.

Echocardiography showed a structurally normal heart. Ophthalmological examination was normal. Ultrasound of abdomen and renal tracts revealed normal kidneys and bladder, but absent gallbladder and pancreas. Although the porta hepatis was not accurately defined, the liver was present, with no significant intra-hepatic bile duct dilatation.

Spinal investigation was prompted by an abnormal plain radiograph which reported a widened spinal canal and by a case series of

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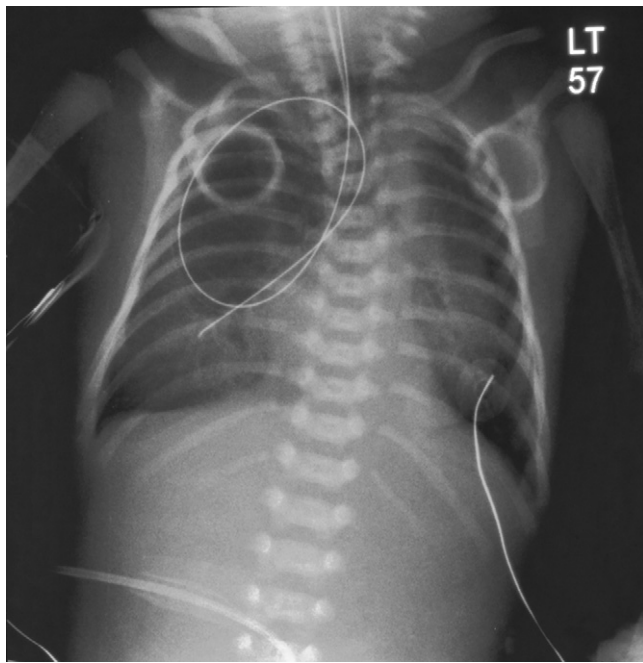


Fig. 1. Chest radiograph with feeding tube curled up in right hemithorax. Cervical vertebral body ossification centres are absent.

two infants with intrathoracic stomach who had associated spinal abnormalities.¹

The extent of the spinal abnormalities was determined using magnetic resonance imaging (MRI) (Fig. 3) and computed tomography (Fig. 4). The cervical vertebral bodies were markedly hypoplastic, with anterior rachischisis, and the ossification centre of the odontoid peg was absent. The spinal canal was capacious and displaced anteriorly in keeping with a possible cervical neuroenteric fistula. The posterior arches were not fused in the midline, but several levels were fused to each other. The right-sided pedicles and laminae were larger than those on the left, and the facets were perched. MRI of the brain was normal.

Spinal precautions were taken within the limits of his size following detection of the spinal abnormality, utilizing a custom

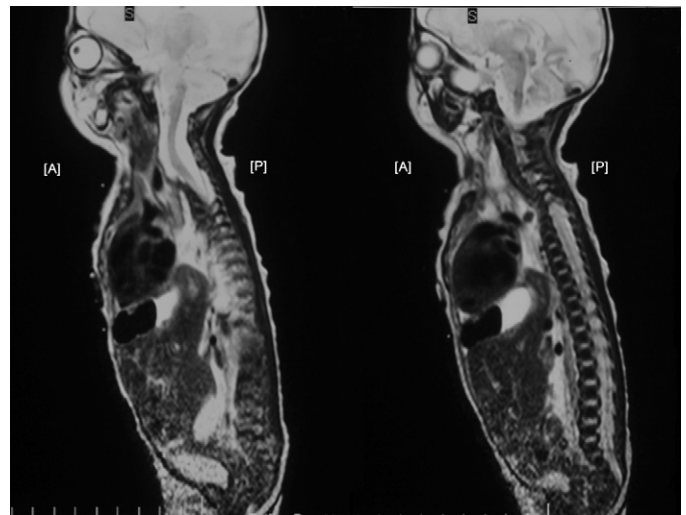


Fig. 3. Sagittal T2 weighted MRI demonstrating a widened spinal canal and multiple level posterior cervical fusion.

cervical orthosis. Weakness of the shoulder girdles was present, although he was otherwise neuro-developmentally appropriate for an infant of his gestational age.

Following a prolonged period of mechanical ventilation and postnatal steroids, the infant was weaned and extubated on day 40 to continuous positive airway pressure (CPAP). He subsequently managed 11 days with no respiratory support before a further deterioration requiring nasopharyngeal CPAP and admission to intensive care. At this stage, ultrasound examination suggested he had no movement of his left hemi-diaphragm and a further short trial off CPAP resulted in a rapid deterioration.

Early re-anastomosis of his gastrointestinal tract was indicated in order to establish oral feeding. A staged technique was considered for oesophageal lengthening, with multiple procedures and a high risk of failure. Stabilization of the cervical spine could be attempted at two years of age, however no precedent existed. The success of spine surgery would rely on sufficient ossification of the skull to allow rib grafting, and safe immobilization until then. Further respiratory support was anticipated, and asplenia posed a higher risk of sepsis from respiratory infections. The constellation of difficulties faced by this infant was considerable.

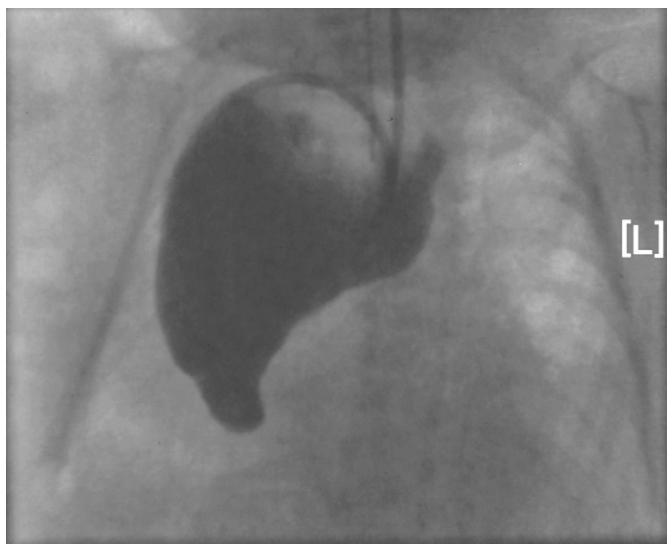


Fig. 2. Contrast study via orogastric tube demonstrating intrathoracic stomach, prior to laparotomy. The greater curvature of the stomach lies superiorly to that of the lesser curvature, suggesting rotation around the blood supply.

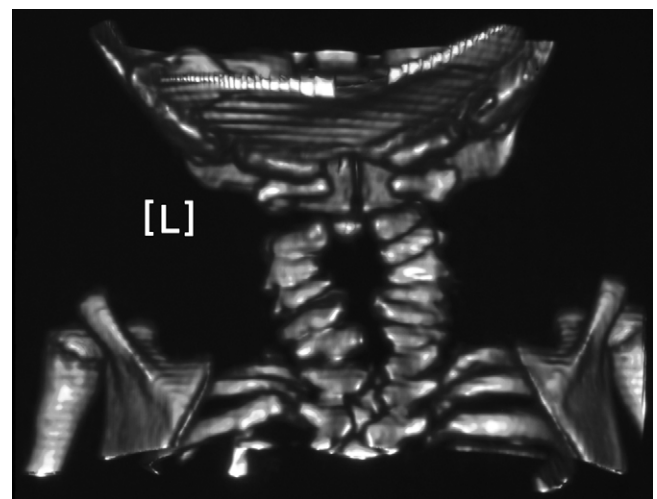


Fig. 4. Posterior view of three-dimensional reconstruction of cervical spine computed tomography. Asymmetrical laminae, perched facets, and anterior and posterior rachischisis are present.

Extensive consultation was made with local specialists and international experts to guide informed discussion with his family. Discussions focused on the experience gained from the only successfully reconstructed case published at that time. A poor prognostic outlook was described, involving long-term enteral or parenteral feeding, and recurrent respiratory difficulties. The strain placed on the infant and the parents during the multiple surgeries and long periods in intensive care were discussed, particularly that this should form part of the counseling.

Following discussions with his family, care was redirected to palliation. The infant died at home two days later of respiratory complications, with care provided by a community paediatric medical and nursing team.

2. Discussion

A variety of surgical interventions have been attempted for similar cases to date. Only one infant has survived to three year follow-up with this condition. In this instance, jejunostomy and gastrostomy were performed, followed by Collis gastropasty and gastrostomy at 18 months (Buffalo, New York).¹ In a second case from the same institution,¹ gastrointestinal reconstruction was not attempted as cardiac abnormalities were inoperable and incompatible with life. The gastric blood supply was from the coeliac axis. An earlier report from Hong Kong,² with a T4-level oesophagus, underwent attempted stomach mobilization. The gastric blood supply was from thoracic arteries, and the friable stomach perforated intra-operatively. Care was directed towards palliation after counseling the parents. The first European case (Rome/Brussels)³ was treated with duodenojejunosotomy and cholecystojejunostomy, followed by gastric tubularisation at 6 months, and a tracheal prosthesis for tracheomalacia. Recurrent sepsis initially settled, but acute obstructive respiratory syndrome later proved unsurvivable. The most recent case, from Tokyo,⁴ involved a feeding jejunostomy, gastric tubularisation, reduction of herniated organs and hiatus plasty. Cardiopulmonary insufficiency led to death ten days after surgery.

It is likely that this condition originates during embryonic development, when there is a close relationship between the proximal section of the gastrointestinal tract and the cervical spine. The embryonic development of the cervical spine begins as the notochord and neural tube are formed. Vertebral body ossification progresses in both directions from T10 to L1, while neural arches begin ossifying cranio-caudally in utero.⁵ Congenital vertebral anomalies include failure of fusion (rachischisis), segmentation (block vertebra), formation (hemivertebra), or combinations of these. Deformities such as scoliosis, kyphosis or hyperlordosis may follow.

In the case described, failure of closure of the somites anteriorly resulted in an incomplete vertebral canal, with anterior rachischisis. In particular, migration of the sclerotome component of the somite around the spinal cord appears to have been interrupted. The fused posterior elements represent a failure of segmentation, resulting in a complex spinal abnormality with instability. Whether a cervical neuroenteric fistula prevented anterior cervical vertebral fusion is unclear. One previous case was associated with diastematomyelia and an anterior cervical neuroenteric cyst at C3.¹ Presacral neuroenteric fistulae and split notochord syndrome are both recognised entities,⁶ as are neuroenteric cysts,⁷ which have allowed prenatal diagnosis on occasion.⁸ Cervical fusion in Klippel–Feil syndrome⁹ has not been associated with such gastrointestinal malformations. Jarcho–Levin syndrome¹⁰ (spondylothoracic and spondylocostal dysostosis) is associated with vertebral body and rib malformations with diaphragmatic hernia, caudal agenesis and urinary malformations.

Tethering of the oesophagus at the level of the cervical spine could account for the presence of foregut organs within the thoracic cavity. One report demonstrated an intrathoracic spleen, pancreas and duodenum.⁴ Foregut malpositioning may induce torsion at the level of the coeliac axis.³ Ischaemia originating at the coeliac axis could account for the absent spleen, and duodenal atresia. Congenital asplenia has been associated with hiatus hernia on MRI studies,¹¹ however congenital hiatus hernia aetiology is related to diaphragmatic defects and laxity of stomach ligaments. One report of an infant with ultrashort oesophagus and intrathoracic stomach,² demonstrates radiographic evidence of cervical rachischisis, but precedes the original description of the syndrome.¹ The term 'serpentine-like syndrome' has been used for this syndrome as snakes have thoracic stomachs and rachischisis. This nomenclature is memorable, however this condition could equally be referred to as embryonic cervical oesophagus syndrome.

The spectrum of hypochondrogenesis, achondrogenesis and skeletal chondroepiphyseal dysplasia may be associated with inadequate vertebral ossification and congenital spinal instability.¹² Disorders on this spectrum are associated with shortened limbs and may be detected sonographically by measurement of femoral length at 16–18 weeks and 22–24 weeks gestation.

Advances in antenatal anomaly ultrasound screening, fetal MRI, and awareness of this syndrome may allow early detection. Presence of an intrathoracic stomach should prompt investigation of the spinal cord. As gross instability of the cervical spine is often associated with lethality in the perinatal period, caesarian section to avoid birth trauma should be considered. Planned delivery of the infant in a tertiary centre with access to paediatric general surgeons, orthopaedics and neurosurgery is preferable.

In this case, early collaboration with international experts made possible a comprehensive evaluation of treatment options, whilst allowing the family to remain close to home.

Conflict of interest statement

None.

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Ethical approval

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contributions

Dargan D: First author, acquisition of data including figures, critical revision, final review.

McMorrow AM: Contributions towards abstract and main body of manuscript, acquisition of data, critical revision, final review.

Bourke TW: Contributions towards manuscript data acquisition, critical revision.

McCallion WA: Surgeon for laparotomy, involved in clinical decision making and data acquisition, and final review of manuscript.

Verner A: Lead Consultant Neonatologist, involved in data acquisition and clinical decision making, final approval of manuscript.

Lyons, J: Lead Paediatric Intensive Care Clinician for a large part of the infants' care, involved in data acquisition, clinical decision making, and final review of manuscript.

McConnell RS: Neurosurgical consultation, involved in clinical decision making, and final review of manuscript.

Lundy CT: Clinical decision making, gaining consent for publication, critical revision of manuscript, final review.

Eames NWA: Clinical decision making, critical revision of manuscript, and final review.

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